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ABSTRACT

The Attitudes toward Mathematics Inventory (ATMI) was developed to measure students' attitudes toward mathematics. The ATMI was initially produced using samples of high school students at a private high school, and the initial pool of items was submitted to exploratory factor analysis. Four factors were identified: self-confidence, value, enjoyment, and motivation. Because the ATMI was developed with high school students, this study was undertaken to see if the four factors would hold with a college population. The ATMI was also derived used a predominantly Hispanic population, raising the question of whether there might be a different factor structure for a different sample. Responses of 134 college students to the ATMI were analyzed. Confirmatory factor analysis was used to determine whether the four-factor model would hold, and results indicate that the four-factor model does hold for U.S. college student. (Contains 2 tables and 18 references.) (Author/SLD)

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CONFIRMATORY FACTOR ANALYSIS OF THE ATTITUDES TOWARD MATHEMATICS INVENTORY

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Paper presented at the Annual Meeting of the
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Abstract

The Attitudes Toward Mathematics Inventory (ATMI) was developed to measure students' attitudes toward mathematics. The ATMI was initially produced using samples of high school students in a private American school. The initial pool of items was submitted to exploratory factor analysis and four factors were identified: self-confidence, value, enjoyment, and motivation.

Due to the fact that the ATMI was developed using high school students, it was unknown if the four factors would hold for a college population. Moreover, the ATMI was derived using a predominantly Hispanic sample, so there was a question about the possibility of a different factor structure for an American sample.

The present study used responses of 134 college-aged American students. Confirmatory factor analysis was used to determine if the four-factor model previously identified would hold for college-aged American students. The results of the confirmatory factor analysis indicated that the four-factor model holds for American college students.

Introduction

Clearly, research has shown that attitudes toward mathematics are important in achievement (Dwyer, 1993). Differences have been found for differential influence of parents (Kenschaft, 1991) and teachers (Dossey, 1992). Attitudes influence success and persistence in the study of mathematics (Chang, 1990; Thorndike-Christ, 1991). Differences in attitudes have been reported for gender, ethnicity, cultural background, and instructional approaches that affect the attitudes of students toward mathematics (Leder & Forgasz, 1994; Murphy & Ross, 1990; Huang & Waxman, 1993; and Hollowell & Duch, 1991). Self-confidence is a good predictor of success in mathematics (Goolsby, 1988; Randhawa, Beamer, & Lundberg, 1993; Linn & Hyde, 1989). Anxiety is directly related to previous school mathematics performance (Hauge, 1991). Terwilliger and Titus (1995) found that positive attitudes toward mathematics are inversely related to math anxiety. Most of this research has been concerned primarily with student in K-12 schools.

Many U.S. campuses struggle to attract students into mathematics beyond the required courses at the undergraduate level. About 1 percent of students major in mathematics at the undergraduate level. Of course, some students with an interest in math are attracted to alternatives, such as computer programming, and some take degrees that lead to immediate employment upon graduation, but there is no question that students avoid mathematics. A study released by the Conference Board of the Mathematical Sciences (Lutzer, Maxwell, & Rodi, 2002).) reported that bachelor's degrees granted in mathematics fell 19 percent between 1990 and 2000, at a time when overall undergraduate enrollment rose 9 percent. The long-term problems for the nation may be affected by the

fact that the pool of potential students who will seek advanced degrees in math is small, and currently over half the students who take graduate degrees in mathematics are foreign. While it seems highly likely that attitudes of college students are important in making decisions about mathematics courses, there is a paucity of research in this area and lack of a valid, reliable instrument for assessing the attitudes of college students. Tapia (1996) developed an instrument (ATMI) for use with secondary students, but there is no evidence to demonstrate that the ATMI is suitable for college students. The purpose of this study was to determine if t he ATMI would be similar in statistical properties with an older population.

The ATMI was developed in several stages. The original instrument was designed to measure six dimensions of attitudes toward mathematics. Extensive item analysis and exploratory factor analysis using high school students resulted in a 40-item questionnaire measuring four factors identified as self-confidence, value, enjoyment, and motivation.

Due to the fact that the ATMI was developed using high school students, it was unknown if the four factors would hold for a college population. Moreover, the ATMI was derived using a predominantly Hispanic sample, so there was a question about the possibility of a different factor structure for an American sample. Therefore, the present study addressed the question as to whether the four-factor model previously identified would hold for college-aged American students. To answer this question, a confirmatory factor analysis was carried out.

Method

Subjects

The subjects were 134 undergraduate students enrolled in mathematics classes at a state university in the Southeast. Seventy-one subjects were male and 58 were female. Five participants did not provide their gender. Approximately 80% of the sample was Caucasian and about 20% African-American. The ages of the sample ranged from 17 to 34. Ten participants did not report their ages. All subjects were volunteers and all students in the classes agreed to participate.

Materials

The Attitudes Toward Mathematics Inventory (ATMI) consists of 40 items designed to measure students' attitudes toward mathematics (Tapia 1996). The items were constructed using a Likert-format scale of five alternatives for the responses with anchors of 1: strongly disagree, 2: disagree, 3: neutral, 4: agree, and 5: strongly agree. Eleven items of this instrument were reversed items. These items were given appropriate value for the data analyses. The score was the sum of the ratings.

Exploratory factor analysis of the ATMI using a sample of high school students resulted in four factors identified as self-confidence, value, enjoyment, and motivation. Self-confidence consisted of 15 items. The value scale consisted of 10 items. The enjoyment scale consisted of 10 items. The motivation scale consisted of five items. Table 1 shows anchor items by factors. Alpha coefficients for the scores of these scales were found to be .95, .89, .89, and .88 respectively (Tapia 1996).

Table 1

Anchor items by factors

Item by Factor
Self-confidence
Mathematics does not scare me at all.
Studying mathematics makes me feel nervous.
My mind goes blank and I am unable to think clearly when working mathematics.
Value
Mathematics is a very worthwhile and necessary subject.
Mathematics courses will be very helpful no matter what I decide to study.
Mathematics is important in everyday life.
Enjoyment
I really like mathematics.
I have usually enjoyed studying mathematics in school.
I am happier in a math class than in any other class.
Motivation
I am willing to take more than the required amount of mathematics.
I plan to take as much mathematics as I can during my education.
The challenge of mathematics appeals to me.

Procedure

The ATMI was administered to participants during their mathematics classes. Directions were provided in written form and students recorded their responses on computer scannable answer sheets.

Results

Confirmatory factor analysis was used to evaluate the viability of the anticipated four-factor model. Several measures were used to assess the model fit: the χ^2 goodness of

fit, the ratio of the χ^2 goodness of fit to the degrees of freedom, the root mean square error of approximation (RMSEA), the normed fit index (NFI), and the expected cross-validation index (ECVI).

The first step in the confirmatory factor analysis was to create a four-factor model with self-confidence, value, enjoyment, and motivation as defined by Tapia (1996). Cronbach alpha coefficients were calculated for the scores of the scales and were found to be .96 for self-confidence, .93 for value, .88 for enjoyment, and .87 for motivation. Correlations for the factors in this model were calculated for 134 subjects and the correlations can be found in Table 2.

Table 2

Correlation Matrix of Variables in the Model

	Self-confidence	Value	Enjoyment	Motivation
Self-Confidence	1.000			
Value	0.524	1.000		
Enjoyment	0.752	0.632	1.000	
Motivation	0.759	0.645	0.813	1.000

The adequacy of the four-factor model was examined using confirmatory factor analysis using LISREL8. The χ^2 goodness of fit was 2.834 which based on 2 degrees of freedom has an associated probability of 0.242. A probability greater than 0.05 indicates a good fit (Shumacker & Lomax, 1996). LISREL run yielded a goodness of fit index (GFI) of 0.99. The adjusted GFI was found to be 0.94. The GFI and AGFI were to be higher than the desired value of 0.90 (Shumacker & Lomax, 1996). The GFI compares the similarity of the sample and the model covariance matrix. A GFI of 0.99 indicates that 99.3% of the sample covariance matrix fits the population covariance matrix.

The root mean square error of approximation (RMSEA) was 0.056. Hu and Bentler (1999) indicate that a value less than .06 shows good model fit. Furthermore, the normed fit index (NFI) was 0.99, the expected cross-validation index (ECVI) for the model was 0.14 and 0.15 for the saturated model. These goodness of fit statistics indicate a good model fit.

Conclusions

The four ATMI factors of self-confidence, value, enjoyment, and motivation reported by Tapia (1996) using a sample of high school students were found to hold for the college-age respondents in the present study. Furthermore, reliability estimates for the scores on the four factors were found to be good as were the corresponding ones of the scores of the high school students.

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